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Root-Knot Nematode (*Meloidogyne incognita*) on Bitter Melon (*Momordica charantia*) near Darwin, Australia

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Abstract The Root-Knot nematode *Meloidogyne incognita* was identified morphologically from diseased Bitter Melon root samples taken from a farm at Buckley Road, Humpty Doo, Darwin. *Meloidogyne* species have been recorded from the Northern Territory on various hosts including bitter melon, but none were identified to species, so this is the first report confirming *Meloidogyne incognita* on Bitter Melon from the Northern Territory, Australia.

Keywords Root-knot nematode diagnosis · Perineal pattern · Bitter Melon pests · Asian vegetables

Bitter Melon (*Momordica charantia*), also commonly referred to as Bitter Gourd, Balsam Pear, Bitter Cucumber, and African Cucumber is a vegetable consumed in most Asian countries with many culinary and herbal medicine uses (Basch *et al.* 2003; Behera *et al.* 2010). In Australia, Bitter Melon is grown mainly in the Northern Territory, Queensland and New South Wales and in smaller quantities in other states to meet local market demand (Morgan and Midmore 2002). Bitter Melon production in the Northern Territory has steadily increased as a result of increased plantings by new Asian growers (Smith 2001) and is an important crop in the Asian vegetable industry (Midmore *et al.* 2004).

In September 2011, diseased Bitter Melon plants showing above-ground symptoms of wilting and dying (Fig. 1) were observed on a farm at Buckley Road, Humpty Doo, Darwin. These symptoms could have been due to several root pathogens, of which nematodes were only one. The root systems of the plants were examined and found to be heavily infected with root-knot nematodes (100 % of root system) forming large coalescing root galls (Fig. 2). The infected root samples were sent to CSIRO Ecosystem Sciences in Canberra, for root-knot nematode species diagnosis.

Female nematodes were dissected from the infected roots and processed for morphological examination as outlined in Shurtleff and Averre (2000). Male and juvenile specimens were obtained from the infected roots by cutting the roots into small pieces and incubating them at room temperature (22 °C) for 48 h in a Petri dish half filled with distilled water. Identifications were confirmed on specimens fixed in formaldehyde for 2 weeks, then processed to glycerol by the slow method and mounted on permanent slides (Hooper 1986). The slides are deposited in the Australian National Nematode Collection held within the ANIC at CSIRO in Canberra. The morphological features of the female, male and juvenile specimens (presented below) matched the most recent description for *Meloidogyne incognita* provided in Hunt and Handoo (2009). Measurements: mean ± standard error (μm) **Female** (N=10) length = 570±65, diameter = 340±50, stylet length = 15±0.5, stylet basal knobs rounded and offset and body pear shaped without any posterior protuberance. Typical perineal pattern oval shape, high squared dorsal arch, striae wavy lateral field absent (Fig. 3). **Male** (N=1) length=1375, stylet length=24, spicule=29, gubernaculum

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Fig. 1 Wilting and drying out of Bitter Melon caused by *Meloidogyne incognita*. Other pathogens or environmental stress may cause similar symptoms either alone or in combination with nematodes, however nematodes are often overlooked in searching for the cause of these symptoms

Fig. 2 Bitter Melon root system showing heavy root galling, characteristic of Root-Knot Nematodes. Although characteristic of the genus *Meloidogyne*, diagnosis to species requires examination of the nematodes

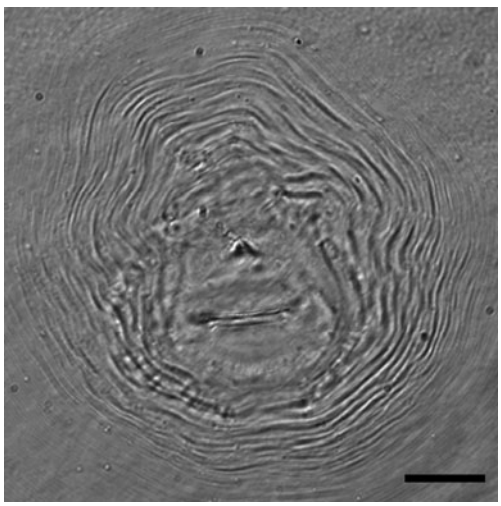

Fig. 3 Typical *M. incognita* perineal pattern showing high squared dorsal arch, wavy striae and lateral field absent. Scale bar=22 μm

length=12, labial region not offset, labial disc elevated, basal knobs offset, rounded. **Juvenile** (N=5) length = 365±30, stylet length = 11±0.5, tail length = 49±5, hyaline tail length = 9.8±0.4, hemizonid anterior to excretory pore, tail tip rounded.

In addition to *M. incognita*, eight other *Meloidogyne* species have been recorded in Australia and can be distinguished from each other based on a combination of morphological characteristics (Table 1). *M. javanica*, the other common root-knot species in the Northern Territory, can be distinguished easily from *M. incognita* on the basis of female perineal pattern.

M. incognita is highly pathogenic on Bitter Melon elsewhere (Anwar and McKenry 2010; Chandra *et al*. 2010; Chen and Tsay 2006). Hence it could become a damaging pest of Bitter Melon in the Northern Territory. The use of green manure (Sudax sorghum) in the Northern Territory and soil amendments (saw dust and chicken manure) by

Table 1 Diagnostic characteristics of *Meloidogyne* species recorded in Australia

Species	Female	Male[a]			Juvenile		References
	perineal pattern	stylet length µm	spicule µm	gubernaculum µm	stylet length µm	tail µm	
incognita	Perineal pattern oval to rounded, striae usually wavy, high squared dorsal arch, lateral field absent or weakly demarcated by forked striae.	25.0 (23–26)	35.2 (28.8–40.3)	11.2	10.5 (9.6–11.7)	46 (38–55)	Hunt and Handoo 2009; Whitehead 1968
javanica	Perineal pattern rounded, striae interrupted laterally by a pair of conspicuous incisures extending on both sides of the tail terminus, low dorsal arch trapezoid shape, tail whorl often distinct.	21.2 (19–24)	26.7 (20.9–31.7)	8.4	10.4 (9.4–11.4)	49 (36–56)	Hunt and Handoo 2009; Whitehead 1968
arenaria	Striae fairly widely separated and mostly smooth, very low dorsal arch, striae bent towards tail tip at lateral line forming shoulders on lateral portion of arch. Lateral incisures absent or unclear.	23.0 (20–28)	32.0 (27.0–39.0)	9.0	11.1 (10.1–11.9)	56 (43.6-69.4)	Cliff and Hirschmann 1985; Hunt and Handoo 2009
hapla	Closely spaced smooth or slightly wavy striae; dorsal arch low rounded; lateral lines present, characteristic punctations usually present near anus.	20.0 (19–22)	25.7 (21.6–28.1)	8.2	9.7 (7.9–10.9)	43 (33–48)	Hunt and Handoo 2009; Whitehead 1968
fallax	Oval shape perineal pattern, striae coarse, moderately high dorsal arch, lateral lines weakly visible.	19.6 (19–21)	26.6 (22.1–29.7)	7.7	10.8 (10.1–11.4)	49.3 (46.1–55.6)	Hunt and Handoo 2009; Karssen 1996
thamesi	Perineal pattern circular shape, dorsal arch very low, rounded or slightly flattened dorsally, no clear lateral lines.	24.9 (21–28)	25.7 (21.6–28.1)	9.2	11.1 (10.2–12.7)	53 (50–58)	Whitehead 1968
trifoliophila	Perineal pattern rounded, long smooth striae, rounded arch, without distinct lateral lines.	18.0 (17–19)	30.0 (27.2–33.5)	8.7	12.7 (11.9–13.6)	69.9 (60.6–87.3)	Bernard and Eisenback 1997
exigua	Perineal pattern rounded/oval, low dorsal arch; striae smooth, widely spaced, coarse, broken and folded in lateral regions; lateral field absent.	18–20	20–26	7.7	9.9 (8.6–11.4)	44 (39–50)	Lordello and Zamith 1958; Whitehead 1968
hispanica	Oval-shaped to rectangular with a low dorsal arch, the dorsal striae fine wavy or coarse, the lateral lines forked with fringe-like striae; distinct phasmidial ducts.	23.5 (22–24)	32.1 (31.1–33.7)	8.3	11.1 (10.4–11.9)	46.4 (41.1–53.4)	Hirschmann 1986

[a] Values are means (range)

Queensland ginger growers to manage root knot nematodes has had some success and could be investigated further as a management option (Conde *et al*. 1999). Further studies on root-knot nematodes in the Northern Territory will be necessary to determine whether there are other species of nematodes causing damage to Bitter Melon, to assess crop losses and to develop better management strategies.

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